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Review of the energy supply status for sustainable development in the Organization of Islamic Conference

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ABSTRACT

This review describes the situation and the varying potential of energy supply utilization of countries in the Organization of Islamic Conference (OIC). This exercise reveals that the increase in energy consumption is associated with economic growth and population expansion. The interconnectivity between energy use and national level, as well as the connection between energy utilization and gross domestic product (GDP), which is an indicator of economic development, must be explained to determine the significance of national energy utility in these countries. Therefore, alternative energy source utilization is necessary for the provision of an appreciable constituent of imminent energy requirements in sectors that utilize energy. Alternative energy source utilization is a crucial factor in ensuring the total capacity of energy sources in various growing economies of the world where clean energy is unavailable. Furthermore, some of these countries also possess alternative energy sources such as hydropower, solar, wind, geothermal, and biomass. This paper provides details on sustainable energy supply developments in OIC countries. These countries must sustainably develop energy despite their sufficient wealth in crude oil and natural gas. The main purpose of this study is to determine economic growth in relation to energy supply to facilitate sustainable development. In addition, this paper suggests necessary requirements to sustain the energy development processes in OIC countries and as well as some stages that must be adopted to enhance development at a sustainable rate.

Contents

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1. Introduction

Energy has become a vital component of human life, particularly in terms of economic activities. Energy is also an indicator of economic and social improvement. Most of the energy supply utilized worldwide is produced from non-renewable energy resources, which are not used sustainably [1,2]. Therefore, the relationship between energy supply and economic growth and development is evident. This close association has been observed between energy production and energy consumption levels on the one hand and between economic growth and development on the other [1,44]. Conventional energy sources still dominate the commercial energy market, with coal occupying the highest market share. Despite having the least share among conventional energy sources, oil seems the most important. The movements of oil prices are among the most closely followed variables in the world. Oil variables remain at the center of world international relations and policy-making debates. The diminished contribution and weight of oil should have reduced the interest and attention paid to it, but in reality, the opposite is true [1,2]. Indeed, the increase in energy demand may be premised on economic growth and on the non-linear changes in social status. These growths could also be controlled by industrialized countries. To meet future demand, a continuous exhaustion of local resources is necessary. Fossil fuels alone cannot supply global energy needs. Consequently, studies are being undertaken to replace energy sources worldwide [1–3].

Sustainable energy development requires the long-term sustainability of energy resource. Sustainability also refers to the performance of all required tasks without causing passive social effects. Energy sources such as fossil fuels, natural gas, and other energy resources such as solar, wind, and hydro are assumed to be renewable. Therefore, sustainability will exceed the relative outlying term strategies [3]. Fig. 1 shows a schematic of sustainability for long-term development.

Renewable energy sources are responsible for meeting 15–20% of the total world energy demand [3]. All renewable energy sources produced nearly 2900 TWh in 2001, which is approximately 24% of the total global electricity supply. If the conventional utilization of biomass is also considered, then most efforts in the renewable field with respect to the current electricity supply will be made possible by hydroelectric mechanisms, of which a huge percentage has been in existence for a long time [2,3]. Nevertheless, the significance of recent engineering work in this field is only starting to unfold. From a pilot scale perspective in the 1970s, the latest class of renewable energy such as biomass, geothermal, small-scale hydro, solar thermal, and others, has been increasing exponentially and has become even more important than technology as far as the supply of electricity is concerned. However, in terms of the utility of these new resources, several steps are being undertaken by people across different races, regions, and geographical areas [2,3].

This study will investigate the effects of energy supply on sustainable development, as well as the necessary requirements for sustainable development processes based on the energy supply of OIC countries. The majority of the data used in the study are based on those obtained from the energy section of the World Bank Development Indicators (WBDI) and the Statistical, Economic, Social Research Training Centre for Islamic Countries (SESRIC). Energy data from different sources are converted to a standard unit based on the Metric Ton of Oil Equivalents (MTOE). These conversion factors are used to standardize countries. Some data were unavailable for some OIC member countries (MCs).

1.1. OIC: selection of countries and population

The aftermath of an arson attack on 21 August, 1969 facilitated the establishment of the OIC on 25 September, 1969 in Rabat, Morocco. The Secretariat's work gradually expanded during the 1970s. The Mecca declaration in 1981, which was centered on enhancing trade and commercial collaboration among the participating states, resulted in a total turn around. With 57 member states, the OIC is the largest organization aside from the United Nations (UN). The OIC is made up of countries with peoples who are mainly followers of Islam. OIC countries represent a substantial portion of the world's developing countries or approximately 21.60% of the world's population, thus possessing significant human, material, and natural resources and exhibiting considerable potential for cooperation and exchange with various sectors [4,5]. Fig. 2 shows the structure of cooperation between OIC countries with their corresponding flags.

According to recent information, Muslims constitute approximately 22% of the global population of 1.5 billion people. The overall global population was approximately 6.6 billion in 2009, with an increase rate of 1.8% from 2000 to 2006. A faster rate of population growth was observed in Muslim nations compared with western nations over the same period. A 3.3% average increase in the rate of population growth was observed in 57 OIC countries [4]. Notably, the demography of the OIC MCs differs noticeably. For example, Pakistan, Bangladesh, and Nigeria are among the world's most crowded countries with populations exceeding 100 million, including Indonesia with over 200 million people. By contrast, eight OIC MCs have less than 1 million people, including Suriname, Brunei, and Maldives, which have fewer than 500,000 people. Based on the 2008 world population, five other countries with populations less than 1 million are Qatar, Djibouti, Bahrain, Guyana, and Comoros. The growth rate of the world population has been declining [4–6].

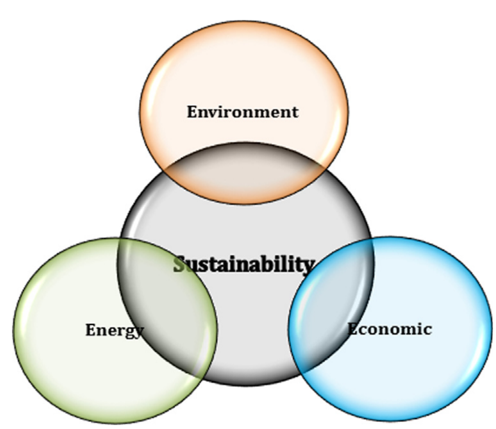


Fig. 1. A schematic of sustainability for sustainable development.

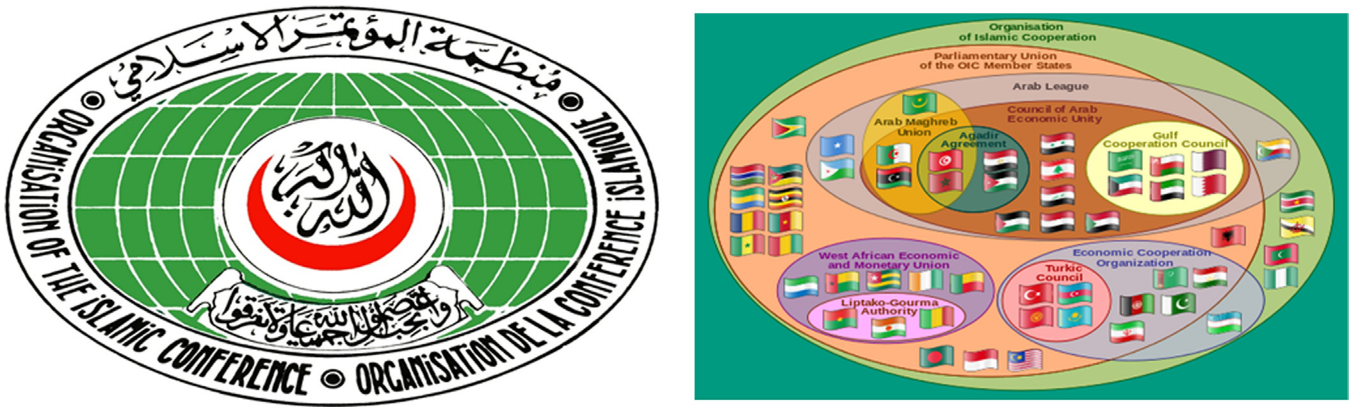


Fig. 2. Structure of the cooperation between OIC countries with their flags.

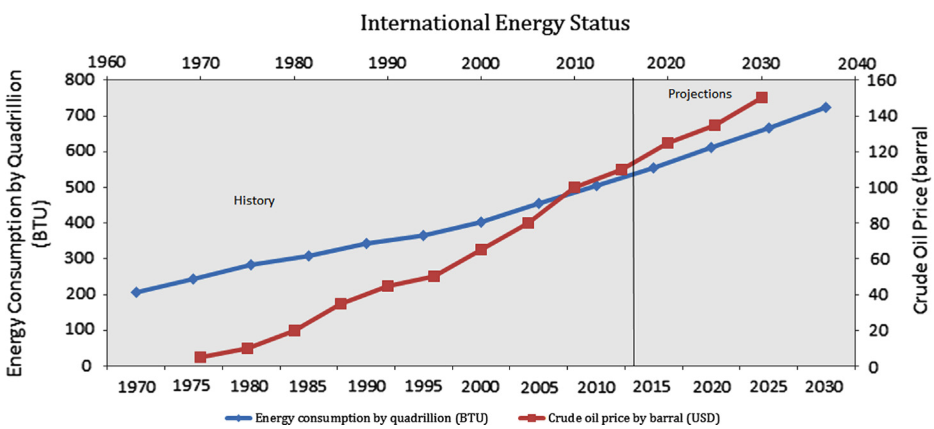


Fig. 3. International energy statuses with the prices outlook.

1.2. Energy as basis for sustainable development

Energy is a motivator of genuine economic growth, but the availability of appropriate services (an anomaly) could impede development. This anomaly restricts the possibility of achieving some set goals and the primary needs of end users such as those in the medical field, engineering, arts, and sciences. This anomaly also restricts the delivery of infrastructural, domestic, and industrial amenities. Sustainability and environmental friendliness must be considered in the use of renewable resources to achieve some of these special goals [6]. A well-defined energy source is basically regarded as a necessity; its availability is insufficient for the total transformation of society. In addition, a self-maintaining mechanism requires a sustainable energy source, which is generally available in the long-term, could be managed at an affordable cost, and could thus be useful in all set tasks with no adverse consequences. The availability of energy from fossil fuels and uranium is time-dependent because these sources are limiting in nature. By contrast, some alternative sources of energy such as solar, wind, and biomass are non-limiting in nature and are thus renewable and could be utilized and reutilized several times [7,8].

The constant availability of energy positively influences the technological and engineering advancement of developed economies worldwide. Most of these advancements result from the mechanisms that used fossil fuel deposits in different places around the globe. These fossil fuels, which are often obtained from developing countries where the technical know-how for meaningful exploitation is often unavailable, had assisted developed countries in maintaining their status at the forefront of the world economy while shaping the life and policy of less-developed countries [9].The high sustained rates of economic growth in developing countries occurred from 1973 to 1981 when oil prices were still unstable. The energy demand of developing countries increased during a time when the rate of oil prices was higher compared with the demand of other industrial countries. The price of fossil fuel worldwide has recently decreased, but the energy supply prices remain considerably higher than in the beginning of the 1970s. If the growth of energy demand accelerates, sustainable energy will require the importation of crude oil and other resources. Energy could again pose a major threat to further economic development in developing countries [45].

Global energy consumption over the last 50 years has taken a quantum leap and is anticipated to rise for the next half century [10]. Fig. 3 shows the rising need for fossil fuels. The remaining fossil fuel deposits are expected to be depleted by 2020. The increases in the prices and demand for crude oil are results of the 1970 and 1990 crises, which strengthened the quest for renewable sources of energy [11]. Before the 1970s, the price of oil was comfortably affordable within the cost of living. However, during the 1970s, these affordable prices started to rise and steadily increased. A perpetual presence of power shortages was experienced in less developed nations because of the rising oil prices. Consequently, the actual cost of fossil oil utility in less developed countries became higher than the corresponding costs of renewable energy sources. However, with the availability of alternative energy sources, price differences are determined by the choices made by consumers. In 1970, oil-producing countries belonging to the Oil Producers Association increased the price of crude oil from 2 dollars to 10 dollars per barrel. This price increase generated confusion and problems in the global market. This situation was

heightened by the constant increments in the prices of oil barrels [9–11]. Fig. 3 shows the international energy status with price outlook. The data were obtained from the Energy Information Administration in 2005. According to these data, the situation accompanied by increments in crude oil demand will continue until 2030.

1.3. Concept of sustainable energy development

Sustainable energy drives the quest for a robust economy aimed at profit-making. The role of sustainable energy in creating a viable economy has been identified and recognized globally. Moreover, historical facts and figures suggest a strong proximity between the availability of energy and economic activities [8]. Energy is an important factor in solving the day-to-day challenges of human beings. Energy accomplishes diverse operations, which often results in mechanisms that ensure the improved well-being of humans. Nevertheless, the link through which the services are made available to end-users and its mode of utilization adversely affect the environment, such as through various cases of air and water pollution [12]. The concept of sustainable energy refers to a system that visibly ensures environmental friendliness in addition to the generation of chances and avenues for social and economic advancement.

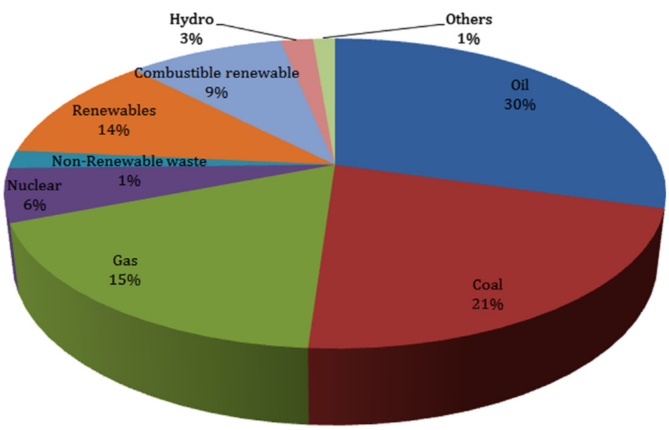


Fig. 4. Share of world primary energy supply 2008.

1.4. Increasing energy consumption and the shift to commercial forms of energy

Prior to the industrial revolution, human activities were centered around natural energy flows as well as on the efforts of fellow human beings to generate different forms of energy. Mechanical energy sources were restricted to draft animals, wind, and water. Burning different forms of biomass remained the only available means of converting energy from one form to another, i.e., chemical energy to heat and light. The use of energy per capita was beneath 0.5 TOE of oil per year. A marked difference was observed in the demand and subsequent use of energy from 1850 to 2005 from approximately 0.2 TOE to 11.4 billion TOE [13]. As societies became more industrialized, the use of different forms of energy have become a hallmark within the polity because of the diverse ways by which energy is being utilized, which ranges from domestic to industrial usage. Several transformations in the use of fuel have been identified, from primitive dung to wood or crop residues and, recently, to largely commercial forms such as crude oil, natural gas, and electricity. Obtaining the statistics on the usage of conventional wastes and biomass is often difficult. However, these fuels have accounted for approximately 10% of total basic energy use at present. A larger extent of this usage is found in the villages and the countryside of less-developed countries. Additional accurate data on commercial energy use, which rose swiftly in the latter part of the 20th century, are also available. Considering that the origin of most commercial forms of energy is fossil fuels (coal, crude oil, and natural gas), the usage of such energy sources surged within the 20-fold vicinity in the 20th century alone. Fig. 4 shows that approximately 76% of the global basic energy supplies came from non-renewable, carbon-releasing fossil fuels, whereas approximately 24% of the global energy supply is combustible and renewable [13].

Current energy needs are being met by non-renewable resources such as petroleum and natural gas. Nine members of the Organization of the Petroleum Exporting Countries (OPEC) currently own 84% of the world crude oil reserves, seven countries

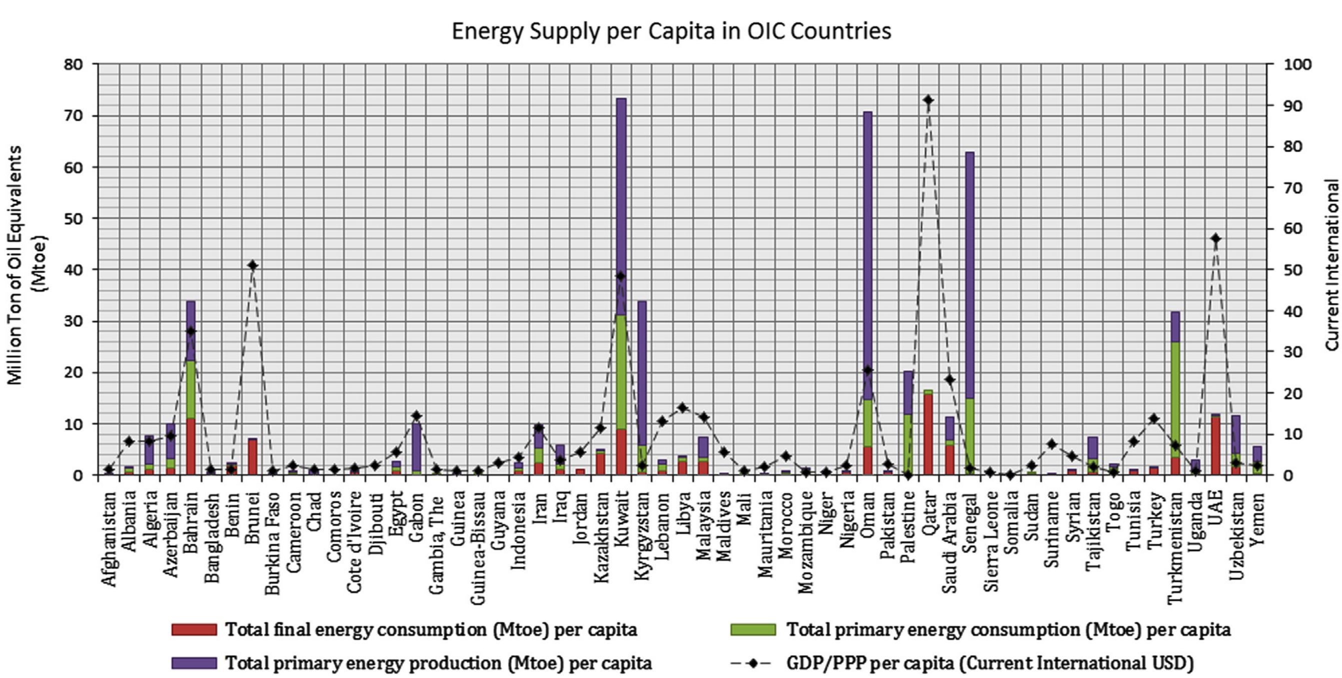


Fig. 5. Energy data (indicators) per capita in OIC countries.

Table 1
The classification of OIC countries as respect to GDP per capita.

The classification of OIC countries as respect to GDP per capita (USD$) (2009)	
Group of economic	**Number of OIC countries**
High-income economies: (GDP per capita > 10,000 USD)	14 countries
Upper Middle-income economies: (5000 USD < GDP per capita > 10,000 USD)	9 countries
Middle-income economies: (1500 USD < GDP per capita > 5000 USD)	18 countries
Low-income economies: (GDP per capita < 1500 USD)	14 countries
No-income economies: (GDP per capita = 0000 USD)	2 countries

own 72% of the natural gas reserves, and eight countries own 82% of all coal reserves. All these countries are OIC MCs [4]. Furthermore, most African and Asian countries import more than half of their commercial energy. Therefore, the problem is rooted in the non-stop energy generation requirement in these countries. The world faces an unsustainable supply of energy in the future if polities will not revamp their energy policies by 2030. Worldwide primary energy consumption will increase by 60%. This increase started in 2010 and will continue until 2030. Accretion demands will occur mostly in developing countries. More than 86% of these demands will be met by fossil fuels. Greenhouse gas emissions will also increase by 59% [43]. Some forecasts on global oil usage indicate that the usage will continue to grow exponentially and would reach an all-time high by 2050 [13]. Interpreting these data from an environment-friendly perspective, the worrisome trend of continuous fossil fuel consumption accounts for almost all energy sources consumed globally with the corresponding consequences [9,13].

The rising demand for energy coupled with increasing oil prices and unstable energy supply are jointly responsible for the uprising in the energy market. Moreover, the recent global economic downturn caused a flurry of activities in attempting to revert to the normal schedule in the energy market. Under these highly charged circumstances, several countries are refocusing their energy policies to comply with sustainable developmental goals and objectives. Energy efficiency and strategic performances of some countries should be appraised to sustain the process of economic recovery. However, most of these factors possess major economic bearings aimed at enhancing the industrial values of modern economies [14]. Previous studies have highlighted various mechanisms for controlling energy factors, but accurate energy markers for standardizing economic systems over a long period of time are yet to be examined [14–17].

2. Energy supply in OIC countries

2.1. Energy supply related with GDP (per capita)

This paper did not use an undisputable criterion for defining Muslim countries. Muslim countries are defined as all countries identified with the OIC regardless of the percentage of Muslims in their population. Countries with Muslims as the majority of their population are also included in the classification [18]. Among the 154 less-developed countries identified by World Bank in 2010, 57 were Muslim countries. Fig. 5 shows selected energy indicators such as energy supply per capita, primary energy consumption, production, and final energy consumption for all OIC countries. Data were obtained from the World Bank in 2008.

These indicators enable a comparison of GDP per capita with the energy supply of each OIC country. The comparison shows that the GDP per capita in the majority of these countries remain very low, but countries such as Qatar, the United Arab Emirates (UAE), Saudi Arabia, Libya, Kuwait, Bahrain, Brunei, Oman, and Turkey have high GDP per capita because they are net oil exporters, OPEC members, and have less population than others. Some countries that are not net oil exporters have high GDP per capita because they have alternative energy resources, which balance the consumption and production of energy supply. Among these countries are Gabon, Malaysia, Indonesia, Kazakhstan, Egypt, Sudan, Yemen, and Tunisia. Only a few indicators were investigated because of insufficient data. Thus, only a few important factors can be explained in OIC countries.

GDP per capita is one of the indicators of the efficiency of an energy input, whereas barrel of oil per capita is an indicator of energy efficiency [14]. The connection between energy supply and use has been an issue of discussion and an object of investigation in studies over the last half century. Previous studies have focused on different countries and used different inputs for the supply and use of energy [19,20]. However, the results of some of these studies were not uniform in terms of the causes of the shift in direction and the comparison between long-term and short-term effects on energy policy, but the implications of these policies could be very significant [20]. However, the focus on the cause of this relationship may not be straightforward despite the well-established status of the relationship between energy use and economic growth, irrespective of which are economic growth and energy consumption, which are interrelated. The numerical implication of finding the path of causality between energy utility and economic exercises for less-developed and well-developed countries has been established [21]. Fig. 5 shows that domestic economic growth has a significant effect on increments in the level of per capita energy use. An increment in the GDP per capita is equivalent to an increase in energy use per capita. However, this relationship may not necessarily be linear and proportional, and differences may be caused by several factors such as energy efficiency, industrial structure, and climate change.

2.2. Economic growth

GDP is a high-profile domestic socio-economic indicator, which appropriates the total domestic and foreign output of each country across the world [22]. According to the data of the World Bank in 2010, this classification depends on a number of indicators, including socioeconomic indicators. These indicators are characterized from a range of zero to $10,000 USD. The 57 OIC countries are classified into five major levels, namely, high, upper middle, middle, low, and no income economies. The classifications of these countries are explained in Table 1 because they cover a wide economic range.

2.3. Effects of energy supply on GDP

Energy is considered in the production process because it is used for commercial and non-commercial activities. Thus, energy

is directly related to a country's GDP. This relationship could be through usage, trade, or commerce because energy generation and use affect the constituents of overall demand. A large number of less-developed countries do not possess crude oil deposits. Thus, these countries are devoid of adequate energy resources and consequently depend on the importation of natural gas, coal, crude oil, or its refined form for most of their domestic and industrial supply of energy for activities such as cooking, transportation, and maintenance of infrastructural amenities. Electricity serves a critical function in the provision of infrastructural amenities. Thus, the existence of a correlation between energy use and economic development is highly probable. Any adverse action on energy will negatively affect GDP because of the very strong interdependence between energy and economic growth. If the supply of energy eventually fails to satisfy demand, the value of GDP will definitely drop [24].

Table 2
An energy classification of 57 OIC countries with respect to the export & import of crude oil.
Source: World Bank data 2007 and SESRIC data 2008.

The energy classification of most of 57 countries in OIC state with respect to the export & import of crude oil				
Oil exporters		**Oil importers**		
OPEC	**Non-OPEC**	**0% to 50%**	**50% to 75%**	**75% to 100%**
Algeria	Oman	Bangladesh	Burkina Faso	Jordan
Iran	Kazakhstan	Benin	Albania	Chad
Iraq	Indonesia	Cote d'Ivoire	Kyrgyzstan	Comoros
Kuwait	Turkey	Mozambique	Morocco	Maldives
Libya	Gabon	Pakistan	Syria	Mali
Nigeria	Malaysia	Senegal	Lebanon	Mauritania
Qatar	Egypt	Tajikistan	Djibouti	Niger
Saudi Arabia	Brunei	Togo		Sierra Leone
UAE	Sudan	Tunisia		Uganda
	Azerbaijan	Guyana		Gambia
	Cameroon	Afghanistan		Guinea
	Bahrain	Uzbekistan		Guinea-Bissau
		Turkmenistan		Somalia
		Yemen		Palestine

2.4. Importation and exportation in OIC countries

Importation and exportation refer to the movement of goods across international borders with respect to a country and its neighbors. However, these activities do not ensure that goods pass through the appropriate legal channels and routes [25]. Table 2 shows some selected OIC MCs classified as exporters or importers. The examination of the global situation with respect to the use of alternative energy sources among OIC countries is saddled with factors that must be considered [23,25]. Some of these factors are mentioned below:

- Appropriateness of the mechanism
- Previous research findings and their practicability
- Proximity to adequate and appropriate human resources
- Production potential
- Economic accessibility

As shown in Fig. 6, petroleum reserve and GDP are not directly correlated. Countries such as Algeria, Iran, Iraq, Libya, and Nigeria have sufficient reserve, but they have low GDP. By contrast, countries such as Turkey, Turkmenistan, Tunisia, Malaysia, and Azerbaijan do not have sufficient reserves, but their GDPs are relatively better. Table 2 shows the critical crude oil situation in 22 of the OIC countries. Most of these countries constitute the low-income economy group. However, a high fractional percentage of these countries (approximately 35 countries) depend totally on crude oil importation.

3. Role of alternative energy sources in supporting fossil fuels worldwide

Energy accomplishes almost all daily human activities related to metabolism, health care, telecommunications, and manufacturing. Currently, fossil fuel can cater to all global energy needs, but fossil fuel deposits around the world are tending toward depletion. Thus, all activities associated with fossil fuels are expected to come to a stop. About a quarter of a century ago, the use of renewable energy started to gain prominence because of the crisis that engulfed the world oil market. However, about 10 years ago, the

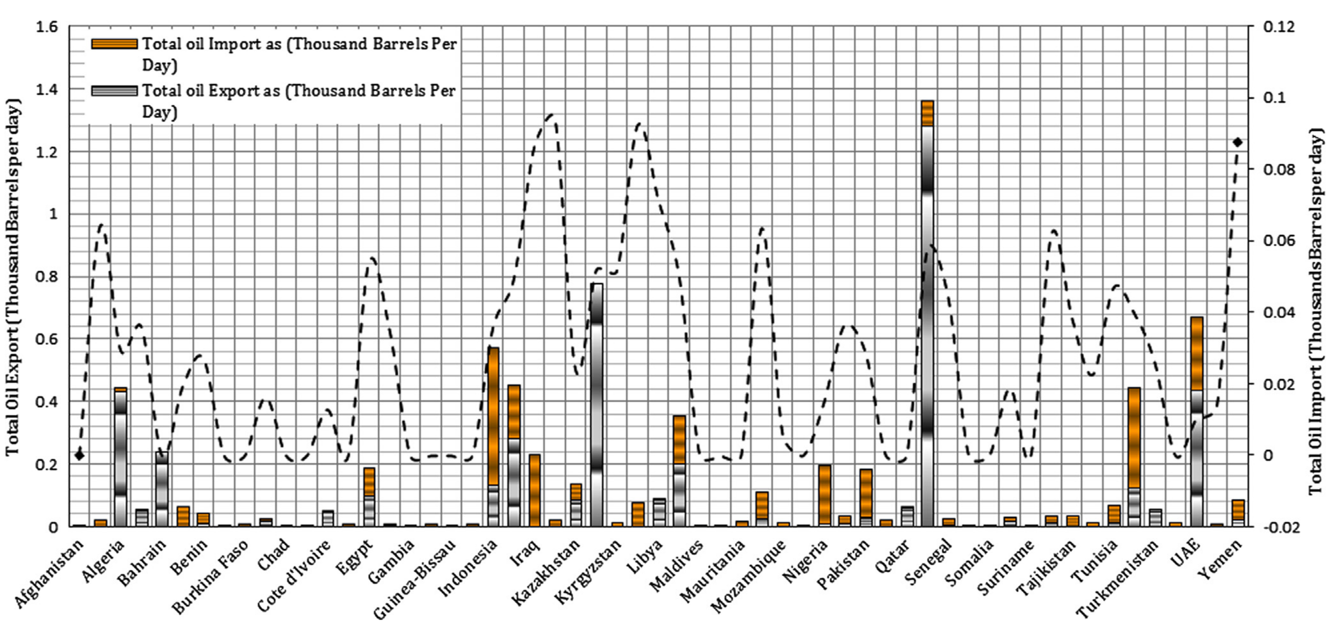


Fig. 6. Total exports & total imports of refined the petroleum product.

attention gradually shifted to creating a safer environment for everyone to live. In addition, other disadvantages associated are with the use of fossil fuels [26]. The answer to the problems resulting from the use of energy with limited natural sources lies in the group of energy with non-limiting natural sources. Some non-limiting sources of energy include the solar, wind, waves, hydropower, and biomass [2,26]. Therefore, energy resources are important for all countries from an economic and political perspective. For this reason, technological change in energy systems is a very important and inevitable factor that researchers should focus on [41,42].

The future of renewable energy resources as the main sources of global energy consumption cannot be over-emphasized, as evidenced by the various professional bodies that associate themselves with the prospects of renewable energy. If all the necessary mechanisms, precautions, and technicalities are considered, the World Energy Conference predicted a two-fold rise in renewable energy sources by 2020 and a three-fold growth by 2030, as shown in Fig. 7. Based on recent documents and policies obtained from the field, this target will likely be met notwithstanding the foundational problems experienced initially. The prospects of renewable energies compared with fossil fuels are peculiar to specific countries. The attendant market strategies may be slightly complicated because several factors are considered. Peculiar circumstances of each nation must be meticulously examined, including the inherent factors, to guarantee the viability of renewable energy as a replacement for fossil fuel [22,23].

4. Energy consumption and production in OIC countries

Energy is involved in basic socio-economic activities. Thus, energy consumption is one of the pillars of modern life. The production and consumption of commercial energy give rise to a number of important contemporary issues [1]. In this regard, economic and social developments are largely dependent on energy. Nevertheless, the modalities of the current energy supply and use may be unsustainable because of certain environmental issues, such as global warming and acid rain, which are consequences of energy use [27]. The OIC region has strategic global importance in current and future energy prospects. Many OIC MCs are blessed with sufficient energy potential, whereas other MCs are not so fortunate. However, energy issues pose serious challenges for all OIC MCs. Accordingly, energy-related issues hold a special position for OIC. Therefore, energy problems related to production and demand are among the main issues faced by developed and developing countries alike. In subsistence life styles, energy sources are products of the local environment, and, in that sense, are not full market commodities. More complex settings depend primarily on commercial energy. The more developed an economy becomes, the more dependent it becomes on commercial energy. The importance of energy has increased with the development of economic life and diversification of economic activity. Energy remains a vital input in every aspect of life, especially in production activities. Energy use has become a basic indicator of economic growth and development [1,27].

4.1. Concept of energy consumption and energy production

The use of energy prior to conversion to other forms is referred to as energy consumption [5,46]. In this process, energy would be put to further use in total local production, in addition to the imported stock, but without the quantity intended for exportation or those used for fueling purposes for aircrafts or sea going vessels on international routes. Energy production, on the other hand, refers to the supply of basic energy in different forms such as petroleum (crude oil, natural gas, and oil from nonconventional sources), solid fuels (coal), derived fuels, combustible and renewable fuels, and electricity [5].

4.2. Relationship between energy consumption and GDP/PPP (per capita)

Energy is regarded as a high profile facilitator of events that eventually generates wealth. Moreover, energy is a significant factor in the development of the economy, as widely recognized and acknowledged globally. A large body of evidence suggests the existence of a strong tie among energy availability, economic exercise, and advancements in human living conditions and the overall social well-being of people [28,48]. Another relationship exists between energy usage and economic growth, which has facilitated the emergence of two opposing views. One of these opinions adheres to the idea that the use of energy limits economic growth. The other view argues that energy does not affect economic growth. This situation highlights the neutrality hypotheses, which postulates that the cost of energy is a micropart of the GDP and should therefore have an insignificant effect on output growth. The possibility of an effect of energy consumption on growth, depending on the structures of the economy and the extent of its growth in respective countries, has also been analyzed [29]. The relationship between energy usage and economic growth has been closely scrutinized. However, no clear-cut agreement or statement concerning this so-called energy consumption growth nexus has been arrived at. Decision makers regard the path of causality highly. For example, if the causality path is from energy usage to economic growth, the energy conservation agenda aimed

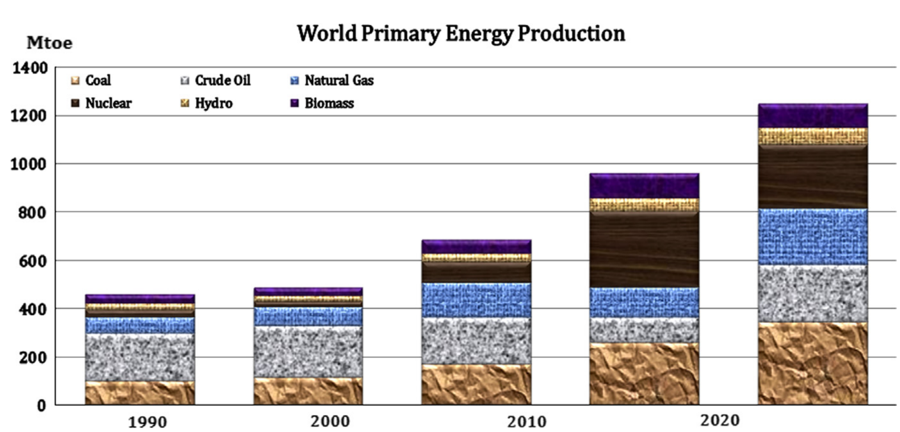


Fig. 7. The total world primary energy production.

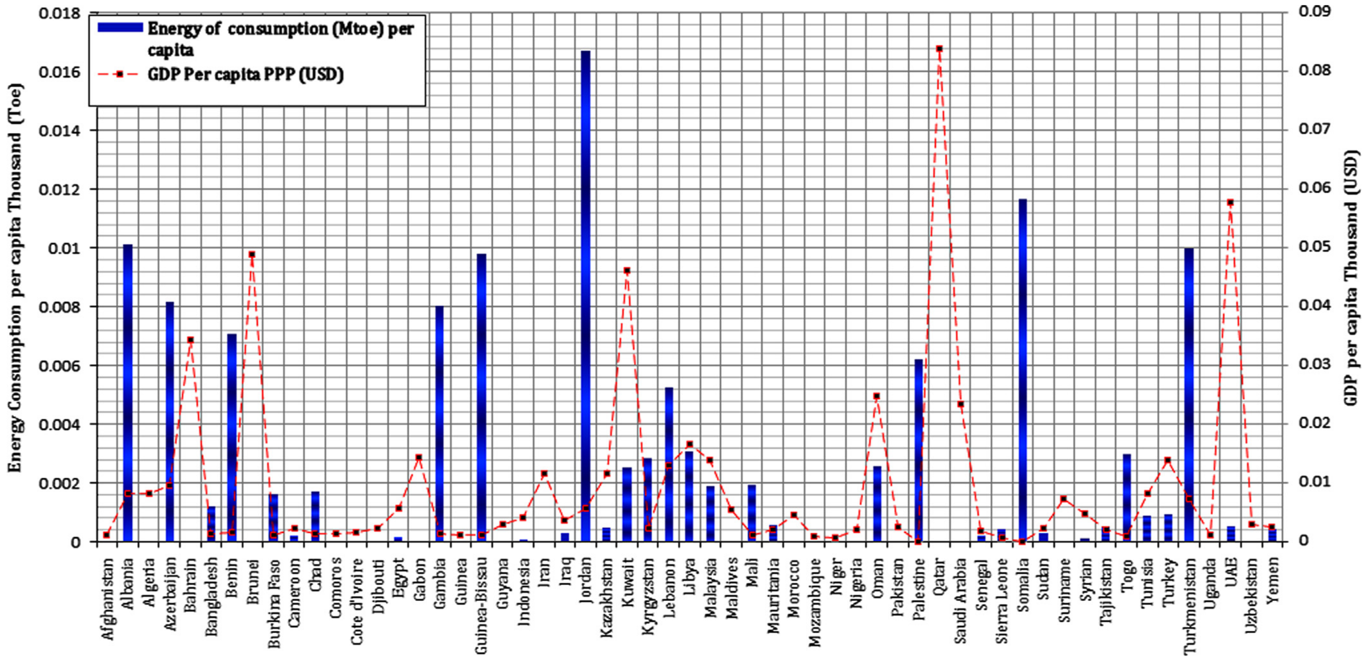


Fig. 8. The relationship between energy consumption & GDP/PPP (per capita).

at bringing down energy usage may have an adverse effect on the growth of economy [30].

The study employed data on OIC countries that have been taken from the 2009 World Bank Data. The relationship between energy consumption and GDP/PPP (per capita) is shown in Fig. 8. The results show that most OIC countries have low GDP, except for some export oil-exporting countries such as Qatar, UAE, Kuwait, Libya, Saudi Arabia, and Bahrain. Thus, the meaning of energy use is not dependent on GDP per capita. Currently, approximately 42% of the global total energy usage relies on crude oil. Twenty-two out of the 57 OIC countries are major oil exporters, and these countries contribute significantly to the world oil commercial transaction. Approximately 61% of the total world population resides in underdeveloped countries but their annual commercial energy usage is approximately 15%. The instability in the world price of oil makes it impossible for the majority of OIC countries, which are major oil exporters, to have a stable economic situation. However, the majority of these countries are blessed with an appreciable amount of renewable energy, particularly solar energy and biomass. Wind energy and hydropower have not been ruled out in some of these countries as well. However, rate of energy consumption and availability of crude oil should not be the criteria for considering alternative energy means. The effects of fossil fuels on the environment are being closely monitored and will continue to attract stricter policies and regulations [22,24].

5. Electricity generation and electric consumption

Sustainability with regard to production and consumption cannot be attained if technology remains constant. The efficiency of the production, transmission, distribution, and usage of energy in countries will be determined by the efforts to regulate the pollution of the environment, specifically by air pollutants comprising mainly greenhouse and other gases as well as other polluting agents particular to such countries. The supply mechanism of electrical energy in most of these countries is being updated to be at par with the latest technology because it has been identified as a strategic contributor to economic growth and improved standards of living [31,32,34].

5.1. Electric net generation in OIC countries

Electricity production is undoubtedly the most important product of the commercial forms of energy. Lighting, heating, and cooling are the first functions that come to mind in relation to electricity. Between 1980 and 1990, electricity generation growth in OIC countries was 6.8% per annum compared with the global growth of 3.6%. In the following decade, the growth rate fell to 4.8% per annum in the OIC and 2.6% globally. In 1980, the share of OIC countries in world electricity production was 4.4%, increasing to 6.0% in 1990 and 7.4% in 2000 [33,42]. The indicators shown in Fig. 9 can be used to examine the patterns and trends of electricity net consumption and net generation, as well as to determine the energy supply in these countries. In the alternative energy policy arrangement, the non-limiting form of energy is a major source that supplies slightly more than a quarter of the total energy consumption. This percentage was approximately 18% in 2004. Electricity generation from renewable energy sources generally rose from 3.21 TWh to 7.84 TWh, thus becoming the second largest source of electricity after coal [34].

The OIC MCs produced 3.03 million TOE in 2008, which was nearly 30% more compared with that in 1998. However, a slight increase was observed globally, wherein the global electricity production from OIC MCs was 25.7% in 2008 and 24.0% in 1998. In the 2007 production level, 18.8% was produced by Saudi Arabia, followed by 10.2% produced by Iran and Indonesia. Four MCs provided nearly half of the total production when the 7.8% share of Nigeria is included. A similar picture can be seen in the consumption side. The OIC MCs were responsible for 12.1% of the global consumption in 2008 with 1.39 million ton of energy use, indicating a 38% increase from its 1998 level. The three leading countries did not show a change in order. In 2009, of the 35.5% total OIC energy consumption, 12.8%, 12.2%, and 10.5% were registered by Indonesia, Iran, and Saudi Arabia, respectively. Nigeria once again ranked fourth with a share of 7.5%, whereas the energy consumption of Turkey made up 6.8% of the total [5,34].

5.2. Renewable and fossil fuels as a source of electricity

In 2005, the global electricity production was 17.58 TWh, 39% of which was obtained from coal, 20% from gas, 16% from nuclear

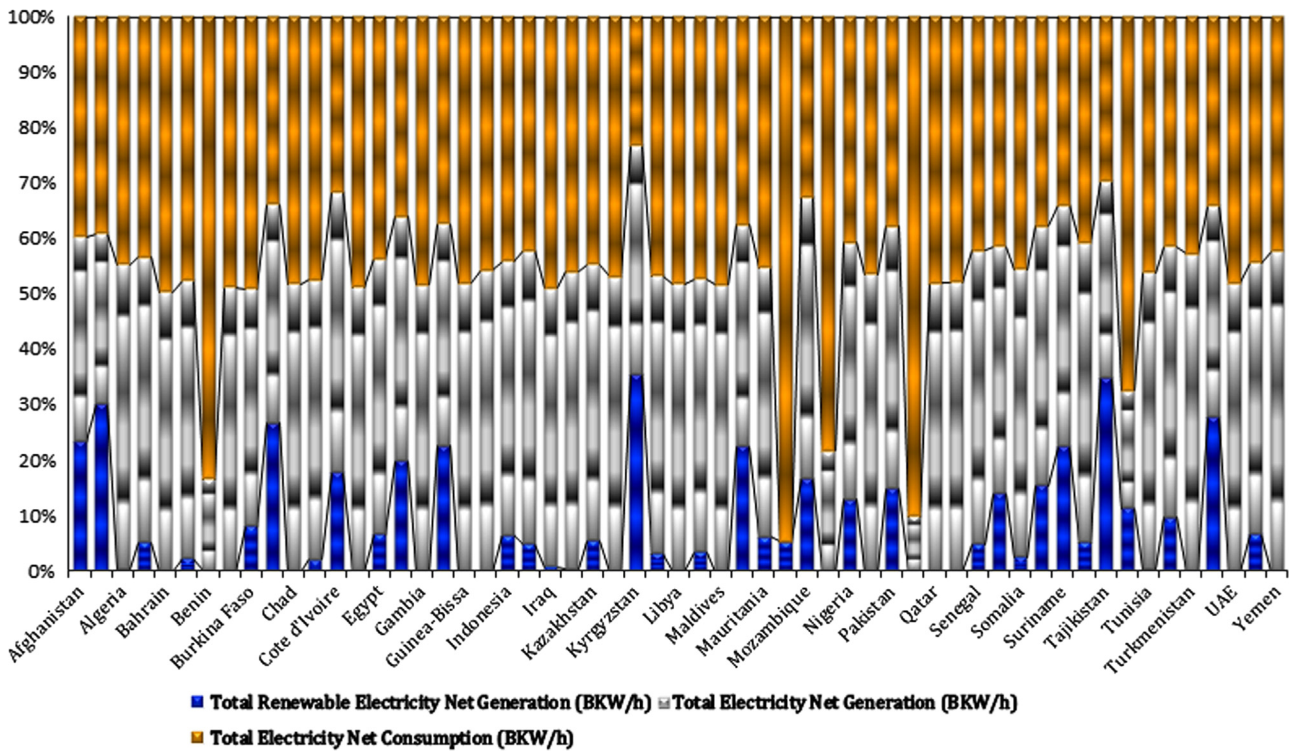


Fig. 9. The electric generation and energy consumption in OIC countries.

Table 3
Sources of electricity net generation (per percentage).
Source: World Bank Data 2006–2007.

Sources	World		High-income economic group OIC countries		Middle-income economic group OIC countries		Low-income economic group OIC countries	
Year	1980	2001	1980	2001	1980	2001	1980	2001
Fossil fuels:								
Coal	33.0	38.2	5.1	11.5	22.3	38.5	13.1	44.5
Oil	28.4	8.4	46.3	27.7	48.0	11.2	53.7	8.2
Gas	8.8	17.2	20.5	44.4	4.6	19.6	1.6	16.3
Total	70.2	63.8	71.9	83.6	74.9	69.3	68.4	69.0
Renewables:								
Hydro-power	20.6	17.5	28.0	16.0	21.6	22.7	27.8	22.7
Nuclear-power	8.5	16.6	0.0	0.0	3.2	7.3	3.7	7.9
Others	0.5	1.5	0.1	0.4	0.3	0.7	0.1	0.4
Total	29.8	36.2	28.1	16.4	25.1	30.7	31.6	31.0

sources, 17% from hydro sources, 8% from crude oil, and 2% from non-limiting sources such as geothermal, solar, wind, combustible, and renewable energies [35,36]. While the global use of fossil fuels for electricity generation decreased by 6.4% between 1980 and 2001, the value increased in the OIC countries by 11.7%. The OIC MCs, which accounted for the highest share (83.60%) of fossil fuels in electricity generation in 2001, are shown in Table 3.

The share of coal, the most important source of electricity production, rose from 33.0% to 38.2% between 1980 and 2001. Moreover, coal shares rose in all of the groups examined and in the OIC during the study period. However, the share in 2001 was 11.5%, the lowest among the groups examined. Between 1980 and 2001, both the low-income and middle income countries experienced a rise of approximately 15% points in the share of natural gas in electricity production, whereas the worldwide increase was approximately 8% points. The use of natural gas as a source of electricity has become an important choice for most OIC MCs. Overall, natural gas was used in the OIC to generate 44.4% of the electricity in 2001, a substantial increase from 20.5% in 1980. The function of oil in the world's electricity production has taken a nosedive since the second oil price fall of 1979. Oil accounted for 28.4% of electrical fuel consumption in 1980, but in 2001, its share fell to 8.4%. More significant decreases in shares were witnessed among the low- and middle-income countries within the same period. The share of oil in electricity fuel use declined from 53.7% to 8.2% among the low-income countries and from 48.0% to 11.2% among the middle-income countries. The share of oil of the OIC in electricity production remained the highest despite the decrease from 46.3% to 27.7%. The use of nuclear power in electricity generation in the world rose from 8.5% in 1980 to 16.6% in 2000. However, the contribution of nuclear power is insignificant for the OIC. In 2001, Pakistan remained the only OIC member country to benefit from nuclear power, which accounted for 0.6% of its electricity generation. In the OIC as a whole, nuclear power accounted for 0.03% of electricity generation [33,37].

5.3. Relationship between electric net generation and electric net consumption in OIC countries

The annual global generation of electrical energy is approximately 3.20 billion kW/h. Renewable energy sources, which include wind,

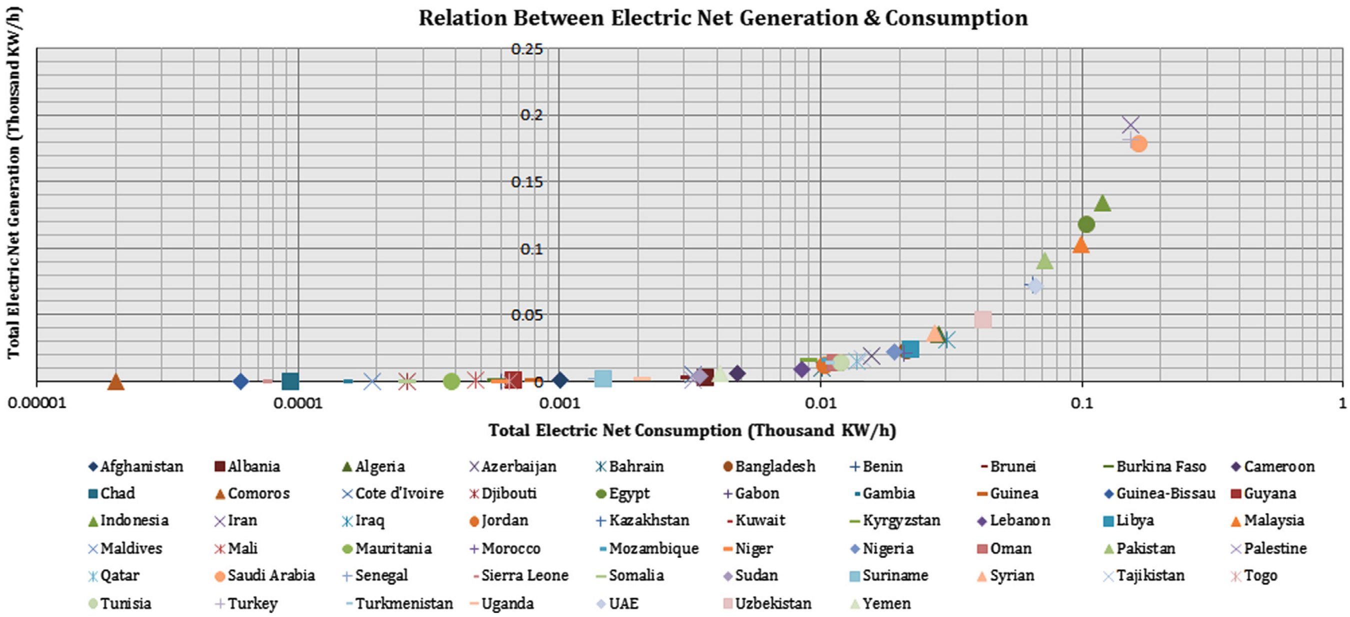


Fig. 10. The relationship between electric net generation and electric net consumption of OIC countries.

solar, biomass, and geothermal energies, make up approximately 22% of the earth's total electricity generation [38,39]. Electrical energy produced from non-limiting sources may be channeled into large grids, but the best benefit of non-limiting sources of energy is its decentralized use. In this case, the advantages of renewability become clear. Renewable sources of energy often play vital roles in places of rural areas where setting up electrical network is generally difficult or non-profitable despite its perceived usefulness in the formidable effort being waged against poverty [31,48]. In 2006, the OIC countries produced 1.63 billion kW/h. In 2000, the OIC MCs supplied 8.5% of the total electricity of the world, whereas the OIC share was 7.4% or 1.12 billion kW/h. However, when comparing the electric net generation and net consumption of 2000 and 2006, the share of the OIC MCs showed a decrease [5,46].

In Fig. 10, Iran is shown as the top producer in 2008, accounting for 12% of the total OIC production with almost 2.16 billion kW/h of electricity. Iran is followed by Saudi Arabia, Turkey, Indonesia, Egypt, and Malaysia. The electricity produced in these six countries constituted nearly 50% of the total OIC electricity production for the years 2007 and 2008.

6. Energy supply balance

Adequate energy distribution facilitates economic proliferation of any country. Access to these modern forms of energy enables extremely low-income people to enjoy some facilities. The design and effective management of an efficient energy supply system is necessary to the success of the goals of the UN Millennium Declaration. Renewable energies, in addition to other mechanisms aimed at improving energy efficiency in developing countries toward the enhancement of quality of life, are designed to achieve these goals. These mechanisms also ensure an enhanced widely distributable network of energy that can reach the remotest areas. This condition can eradicate bottlenecks in obtaining energy supply [31,47]. Directives and guidelines have been formulated by the European Union for the energy sector to guard against certain constraints encountered in energy issues: competitiveness of energy markets, safety of energy supply, and environmental protection. This action ensures an unhindered sectoral developmental scheme with focus on goal delivery. Additionally, these goals as well as their control may be at variance and serve as huge puzzles resulting from provision of solutions to certain energy issues [40,46].

7. Conclusion

The energy status as well as the enormous potential of alternative energy sources in the OIC countries can meet the global energy demand. Therefore, this can facilitate multiple channels of energy supply for the needed long-term sustainable energy supply. This condition will assist in job creation, and in opening up manufacturing prospects particularly in less-developed countries. In addition, an appropriate energy supply scheme plays an important role in enhancing the quality of life across the globe in general and in OIC countries in particular. Besides increased GDP, advances in technological and engineering prowess, cleaner environment, more secured neighborhood, and efficient water supply scheme, numerous employment chances and income generating ventures are some of the benefits obtained from systems where energy supply is effective.

Over the next few years, the focus of both the OIC countries and less-developed countries will be on the cost and availability of energy supply. The choice of alternatives to the conventional energy supply system should be based on abundance, renewability, and impact on the environment. This choice will go a long way in reducing the dependence on imported products, and subsequently improving the GDP as well as the balance of payments of respective countries. In addition, this will assist in protecting the environment from contamination. It is suggested that in planning for the energy supply, national factors such as energy supply infrastructure, energy efficiency considerations, and institutional constraints as well as a sustainable development scheme must be taken into consideration.

The above discussion can be summarized as follows:

(1) Similar to OPEC countries, some OIC countries are blessed with a supply of crude oil and natural gas. The oil and gas industries

in these countries have contributed tremendously to their development as reflected in the high GDP/PPP values.

(2) The countries with extremely low GDP/PPP values have to import crude oil and petroleum products. On the other hand, the use of renewable energy resources such as biomass, biogas, hydro, solar thermal, wind, and geothermal, which most of these countries are naturally endowed with, has remained untapped.

(3) Iran, Turkey, Saudi Arabia, Indonesia, Egypt, and Malaysia were able to generate energy for export. However, they were not able to supply electricity to all areas particularly the remote areas due to insufficient transmission and distribution infrastructure, causing groups of population in these countries to be deprived of modern energy services.

(4) Long- and short-term strategies have to be adopted to promote the alternative energy resources and energy supply. Timeline should be formulated and developed as a guideline for the implementation of the strategies. The timeline can be modified depending on the needs and urgency of the applications of suitable alternative energy resources in the OIC countries.

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